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TOX-ALBUMIN DIPHTHERIA.¹

IN a preliminary communication published in the Hospital Bulletin, No. 15,² we called attention to the histological changes in the organs of animals which had died of experimental diphtheria, following the inoculation of pure cultures of the bacillus diphtheriae. Since then we have extended our investigations so as to include the study of the lesions produced by the inoculations of the toxic products of the diphtheria bacillus. This study virtually finishes the work we have undertaken, and it is hoped soon to publish our results in detail. However, in order to make our preliminary communication complete, we append this report:—

The toxic products of the diphtheria bacillus with which we have operated were obtained by filtering through a new and sterilized Chamberland filter the culture of the organisms in glycerine bouillon, several weeks old. The fluid so obtained was tested by means of cover-slips and inoculations on glycerine-agar, and proved to be sterile.

Guinea pigs were used for the experimental inoculations. The sterile culture fluid was introduced subcutaneously into the tissues of the belly wall by means of a Koch's syringe. The method pursued will be given in connection with the case of which the lesions are to be described. The guinea pig received on Dec. 10, 1891, one cubic centimetre of the filtrate. Not having succumbed on Dec. 14, it received two cubic centimetres more. The animal died on Jan. 5, 1892, the duration of life since the first inoculation having been three weeks and five days, and since the last three weeks and one day.

At the autopsy the vessels of the subcutaneous tissues were injected, and hemorrhage had taken place into the tissues of the axillary and inguinal regions. The subcutaneous tissues were moist, but there was no actual oedema present. Neither was there a visible area of localized inflammation; no microscopical examination was made of the seat of inoculation. The lymphatic glands of the axillary and inguinal regions were enlarged and reddened, the cervical glands were swollen, and the thyroid gland was greatly congested.

There was a considerable excess of clear fluid in the peritoneal cavity. Both layers of the peritoneum were reddened, the vessels of the visceral layer being especially injected. The spleen was enlarged to double the average size. It was mottled, and the white follicles were distinctly outlined against the red ground. The liver was dark in color, and contained much blood. On the surface a prominent yellowish-white area two millimetres in diameter, surrounded by a zone of hyperaemia, was observed. Smaller dot-like points of the same color and general appearance were seen elsewhere in the liver. The kidneys were congested and the cut surface was cloudy. The adrenal glands appeared normal, as did the mesenteric glands.

The pleural cavity did not contain such a marked excess of fluid. The pericardial sac, however, was distended with clear serum. Under the epicardium were many ecchymotic spots. The lungs exhibited areas of intense congestion, or actual hemorrhage into the tissues. The glands of the thorax were, perhaps, swollen.

The examination of the heart muscle by means of frozen sections showed it to be slightly fatty. The epithelium of the tubules of the kidney was extremely granular and much

¹ "The Histological Lesions Produced by the Tox-Albumin of Diphtheria," by Wm. H. Welch, M.D., professor of pathology, and Simon Flexner, M.D., fellow in pathology. From the Pathological Laboratory of the Johns Hopkins University and Hospital. Bulletin of the Johns Hopkins Hospital, No. 20, March, 1892.

² Abstract, Science, No. 457, November 6, 1891.

swollen, but not fatty. The liver was very fatty; the lighter areas and dots were seen to correspond to foci of dead liver cells, whose refractions were much greater than that of the normal cells.

Cultures were made from the blood and organs of the animal, and they remained sterile. Cover-slips also were examined and no organisms found.

The histological lesions observed in this case are identical with those described by us in connection with the inoculations of the living organisms. Lymphatic apparatus: In general, the changes are the same throughout. They are found in the greatest intensity in the glands of the axillary and inguinal regions, and less in the bronchial and cervical, mediastinal, and mesenteric glands. Yet these are considerably affected. The same fragmentation of nuclei affecting the lymph-nodes and sinuses is met with. These fragments exhibit the variety of form previously described by us, and they have the same affinity for coloring agents. Much of the nuclear detritus is free, but a part is contained within large pale cells. In the spleen there is a similar diffuse fragmentation of the nuclei of the spleen cells. Both the lymphoid cells of the follicles and the larger cells of the sinuses are affected. Like the lymphatic glands, some of the nuclear detritus is enclosed in large cells. Besides the destruction of cells in the spleen there is hemorrhage into the organ, or an extreme degree of congestion, so that the tissue elements are widely separated from one another. Nuclear figures occur in the lymph glands and spleen. In the former they are found among the fragmented cells.

Stained sections of the liver, especially those stained in methylene-blue and eosine, show the yellowish-white areas to be composed of hyaline, necrotic liver cells. The necrotic cells stain deeply in the eosine, and they are usually devoid of nuclei. They form, on the whole, more or less definite foci of hyaline cells into which leucocytes have wandered. The largest area was two millimetres in diameter, and the outlines of it were formed by hemorrhage into the tissues corresponding with the hyperaemic zone spoken of above. The cells in this focus have lost their nuclei and they are intensely refractive. Many of the dead cells have retained their individuality, and, indeed, their borders are more distinct than those of the normal cells. Others, however, tend to become fused together and to lose their individual cell outlines. Occasionally, outside the main focus of hyaline cells, single necrotic cells occur, which are surrounded by quite normal ones. Many leucocytes have wandered into this area of dead liver cells, and they are especially abundant at one place in the focus in which the hyaline cells are in process of disintegration. An exquisite nuclear fragmentation is to be observed throughout this area.

Should the focus just described be compared to many similar foci which occur in the livers of animals dead of inoculation with the bacilli themselves, it will be seen to contain more polynuclear leucocytes within it. The explanation of this fact would seem to depend somewhat on the inoculation-time, but more, probably, on the progression, or stage, of the necrotic process. Inoculation of the bacilli usually leads to death in a very short time, twenty-four to forty-eight hours. In this inoculation with the toxic products alone, the incubation period exceeded three weeks. On account of this, time has been allowed for the softening and disintegration of the dead cells, and leucocytes have been strongly attracted to these foci.

In the kidneys, besides the condition described in the frozen sections, a slight fragmentation of the nuclei of the tubular

epithelium is encountered. The lungs exhibit areas of hemorrhage into the alveoli, and in many of these there has been a desquamation of the alveolar epithelium. Sometimes the desquamated epithelial cells are quite normal in appearance, while at others they have fragmented nuclei. The collections of lymphoid cells around the medium-sized and larger bronchi show, however, more cells, the nuclei of which have suffered in this way.

The blood-vessels of the tissues generally contain fewer leucocytes in this instance than in those cases in which the bacilli were introduced beneath the skin. By the latter method an intense local inflammatory process is provoked, associated with the emigration of large numbers of polynuclear leucocytes. In the former, in which the filtrate, free from organisms, is used for inoculation, the local process is reduced to *nil*, there is no emigration of leucocytes, and the disease is general from its inception. This difference is sufficient to account for the occurrence of leucocytosis in the one and its absence in the other case.

It may be considered as established now that the toxic products and not the bacilli themselves invade the tissues in diphtheria. This fact would at once suggest that the general lesions (those produced at a distance from the seat of inoculation in animals, and the situation of the local process in human beings) were the effects of the soluble poison diffused through the body. Hence, it was desirable to demonstrate this assumption experimentally; and it is not unimportant to know that the lesions in the tissues produced by bacilli and the toxic principle on the one hand, and by the toxic principle alone on the other, are in perfect correspondence with each other. And, moreover, it would seem not to be superfluous to emphasize the occurrence of definite focal lesions in the tissues of the body, produced by a soluble poison circulating in the blood.

DESCRIPTION OF A SUPPOSED NEW SPECIES OF STORERIA FROM FLORIDA, STORERIA VICTA.

THE species of *Storeria* here to be described as new was found in the alimentary canal of a specimen of *Elaps fulvius*, which was taken on the banks of the Oklawaha River, Florida, by one of my students, Mr. H. T. Mann. The *Storeria* had been swallowed head first, and had been somewhat digested anteriorly, but the hinder half or two-thirds of the body had undergone little change. Sufficient traces of the cephalic plates were left to show that the latter were those of the genus *Storeria*, the loreal being certainly absent. About twenty-five of the anterior ventral plates were missing, but the number of these could be determined from the vertebræ there exposed.

The dorsal scales are in fifteen rows. When the scales of the middle of the back are compared under the microscope carefully with those of a specimen of *Storeria dekayi* of the same size, the former are plainly of a greater proportional width. Whether or not this will hold true in all cases I can not, of course, say. The ventral plates number 146, counting from the angle of the jaw. There are 60 pairs of subcaudal scales. The anal plate is divided. The total length of the specimen is 14 inches, of which 3 are tail.

The color is gray above, with a tinge of yellow. In the middle of the back are very faint indications of a clay-colored band. This occupies the median three rows of scales. The next row of scales on each side is occupied by an indistinct dusky line and by a row of black specks. These lie distant from one another about the length of two scales.

Lower down on the sides the color becomes paler, but another dusky streak is seen lying partly on the lower row of scales and partly on the out-ends of the ventral plates. The belly is pale yellow, with a row of small, but very distinct, black spots along each side. There is a single spot on each end of each ventral plate, lying about half-way from the middle line of the belly and the outer end of the plate. A few smaller, irregularly placed spots are also seen. The under surface of the tail is plain yellowish white. *Storeria dekayi* sometimes has black dots on the abdomen, but they are irregularly scattered, or at most do not form rows the whole length of the belly.

This species appears to differ from *Storeria dekayi* in the smaller number of dorsal scales (15 instead of 17), in the greater proportional width of the scales, in the somewhat greater number of ventral plates, and in the presence of the two rows of spots on the abdomen. As to the number of ventrals, Mr. Samuel Garman ("Serpents of N. A.", p. 31) states that they vary from 120 to 138. He mentions, however, a specimen from Jalapa, Mexico, which had 145 ventrals. It is possible that the animal which I here describe as new is a specimen of *S. dekayi* with a smaller number of scales than usual, but until there is other evidence of this, it seems better to regard it as different.

From *S. occipitomaculata* my specimen differs in having a considerably larger number of ventrals and subcaudals than have yet been attributed to that species, in the presence of the rows of ventral spots, and in size. The relations of the specimen appear to lie evidently with *S. dekayi*.

The oviducts of the specimen contained a dozen eggs, each somewhat more than a quarter of an inch in length. The coverings of the eggs are extremely thin, from which I infer that the animal brings forth its young alive. This is the case with *S. dekayi*, and probably with the other species of the genus.

The specimen here described will be deposited in the National Museum at Washington.

O. P. HAY.

Irvington, Ind., April 2.

THE HIGHER EDUCATION OF THE DEAF.

THE following letter was recently addressed to President E. M. Gallaudet of the National College at Washington, by Mr. A. L. E. Crouter, principal of the Pennsylvania Institution for the Deaf and Dumb:

PRESIDENT E. M. GALLAUDET, PH.D., LL.D.

My Dear Sir: Since my return from the meeting of the Board of the American Association to Promote the Teaching of Speech to the Deaf, held in your city in January, my thoughts have frequently recurred to a matter of much interest to the association, and, to my mind, of vital importance to your college work, namely, the introduction of oral methods in the instruction of a portion, at least, of the young men and women who come to you for a higher education than the primary schools of the country are able to afford them.

And, in venturing to address you formally upon the subject, I beg you to believe that I am not impelled by any spirit of captious criticism, nor by any desire to intermeddle with the affairs of your excellent and well conducted school, but simply and solely to suggest for your consideration a step which I sincerely believe will, if put into effect, greatly promote and extend the usefulness of the college whose affairs you have so long and so ably directed.

As you are aware, Mr. Greenberger, at our meeting in Washington, brought up the question of oral instruction (recitations) for oral students at Kendall Green, maintaining that, in a school supported by the national government, equal educational advan-

¹ From the *Silent World*.